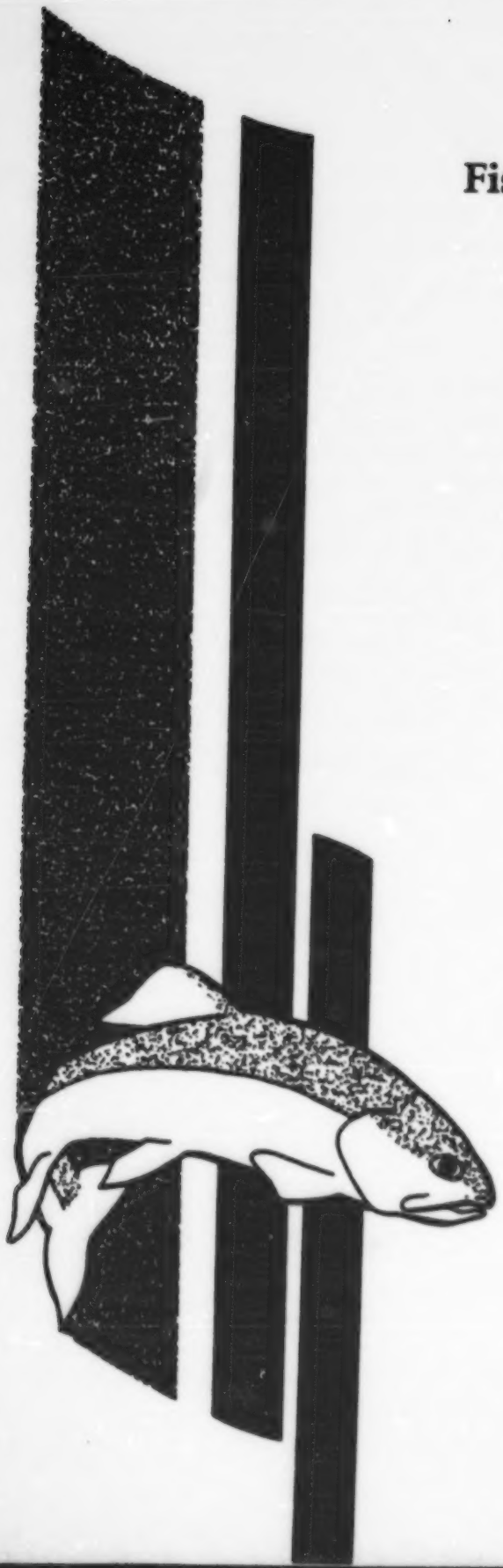

Fishery Development in Barren, Winterkill Lakes

by

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FISHERY DEVELOPMENT IN BARREN, WINTERKILL LAKES

by

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ABSTRACT

Tsumura, K. and V.E. Blann. 1988. Fishery Development in Barren, Winterkill Lakes. Fisheries Technical Circular No. 80. 8 p.

Three graded size groups (mean weights of 5.9, 11.1, and 20.4 g) of age 1 rainbow trout (Salmo gairdneri) were stocked in a barren, winterkill lake in early May to evaluate the effects of size-at-stocking on the incidence of early maturing males and on growth. Growth rates over a 169-day period were 2.1, 2.0, and 1.9% per day for the small, medium, and large size grades. Mean weights in late October were 208.6, 329.7, and 495.7 g for the small, medium, and large size grades, respectively.

Significantly, more males occurred in the large size grade. The sex ratios were 0.7:1, 1.2:1, and 2.1:1 males to females for the small, medium, and large grades. Rates of male early sexual maturation were similar (83.8, 93.4 and 87.3%) for all size grades. Consequently, precociously mature males comprised 35, 52, and 60% of the small, medium, and large size grades in the fall. Relative survival rates were 20, 32, and 48, respectively.

These data suggest a means of separating and utilizing precociously-maturing male trout. Large size grade juvenile rainbow trout stocked into productive, barren, winterkill lakes in the spring will be predominantly early maturing males, and all will be a catchable size by fall.

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Eric Parkinson and Ken Ashley identified and secured Pikes Lake as a research lake. Linda Berg and Angelo Facchin assisted in the data analysis and interpretation. Tom Johnston reviewed the paper and gave many helpful suggestions. Doris McKay assisted with the preparation of the document.

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INTRODUCTION

Fish are routinely graded in hatcheries to reduce size variability in order to provide optimum growth conditions until release. Tsumura and Hume (1986) demonstrated a tendency for the large size class of graded fish to contain more males than the smaller size classes, and also suggested that grading can effectively separate precocious males from nonprecocious males, since early maturing rainbow trout males are faster growing prior to sexual maturation. However, after the spawning period, mature males are of decreased quality, have limited growth, and reduced survival rates (Tofteberg and Hansen 1986).

Tsumura, Hume and Chan (1987) suggest that large graded rainbow trout stocked in the spring will grow to a catchable size by the fall. A winterkill lake stocked with these fish could be used to develop a trout fishery where none existed before. At the same time, the fishery in regularly stocked lakes would benefit since the fish stocked into these lakes would contain fewer precocious males.

There are four potential benefits from separating out large juvenile fish in a grading program: 1) an increase in numbers of later maturing females and males liberated into regularly stocked lakes, 2) utilization of early sexually maturing fish while still in "bright" condition, 3) a high benefit-cost ratio (Appendix 1) from stocking barren lakes, and 4) development of a fall and winter fishery where a fishery did not exist previously.

The purpose of this present study is to repeat a previous study by Tsumura, Hume and Chan (1987) utilizing a more definite graded size grouping in the fish and a barren winterkill lake.

STUDY AREA

Pikes Lake is a productive winterkill lake (TDS ~200 gm/l) situated at an elevation of 975 m on the Douglas Lake Ranch near Merritt, B.C. (50 13'N, 120 01'W). Surface area is 22.5 ha, of which 100% is littoral (< 6 m).

The lake was barren previous to this study and was closed to angling prior to data collection.

METHODS

Grading was conducted at the Summerland Trout Hatchery on May 6, 1987 using slotted wooden graders having aperture sizes of 8 mm and 11 mm. The three graded size classes consisted of fish with mean weights of 5.0 g, 9.3 g and 20.0 g for the small,

medium, and large classes, respectively. Rainbow trout used in this experiment were randomly selected from one year old Pennask Lake stocks reared at the hatchery.

Fish were first anaesthetized in 2-phenoxyethanol and then weighed, measured and batch-marked for group identification. Right maxilla, left maxilla, and adipose clips were applied to the small, medium, and large graded fish, respectively. The three graded groups were held for 24 hr before transportation and liberation in equal numbers. A total of 6000 fish equal to 27% of the yearling capacity calculated from the stocking formula suggested by Stringer et al. (1980) were stocked into Pikes Lake.

Multiple mesh size monofilament gillnet gangs were used to sample the fish on October 23, 1987. Stretched mesh sizes ranged from 38.1 mm to 101.6 mm in 12.7 mm increments (5 mesh sizes). Nets were set in the late afternoon, cleaned of fish periodically, and picked up after dusk. Fish were kept on ice overnight. Lengths, weights, marks, and maturity of the fish were recorded the next day.

RESULTS

INITIAL SIZES

Initial mean lengths and weights of the three graded size classes (Table 1) were significantly different at the time of stocking ($P < 0.05$, GT2 test, Sokal and Rohlf 1981). Length ranged from 60 to 115 mm, 91 to 127 mm, and 110 to 153 mm, for the small, medium, and large grades, respectively. Weight of fish ranged from 1.8 to 14.8 g, 6.8 to 17.1 g, and 13.3 to 32.2 g for the same respective size grades (Fig. 1).

Table 1. Initial lengths and weights on May 7, 1987 (SD in brackets).

Grade	N	Mean Length (mm)		Mean Weight (g)	
Small	34	84.1	(11.1)	5.9	(2.8)
Medium	46	104.9	(8.6)	11.1	(2.9)
Large	49	126.8	(9.6)	20.4	(5.0)

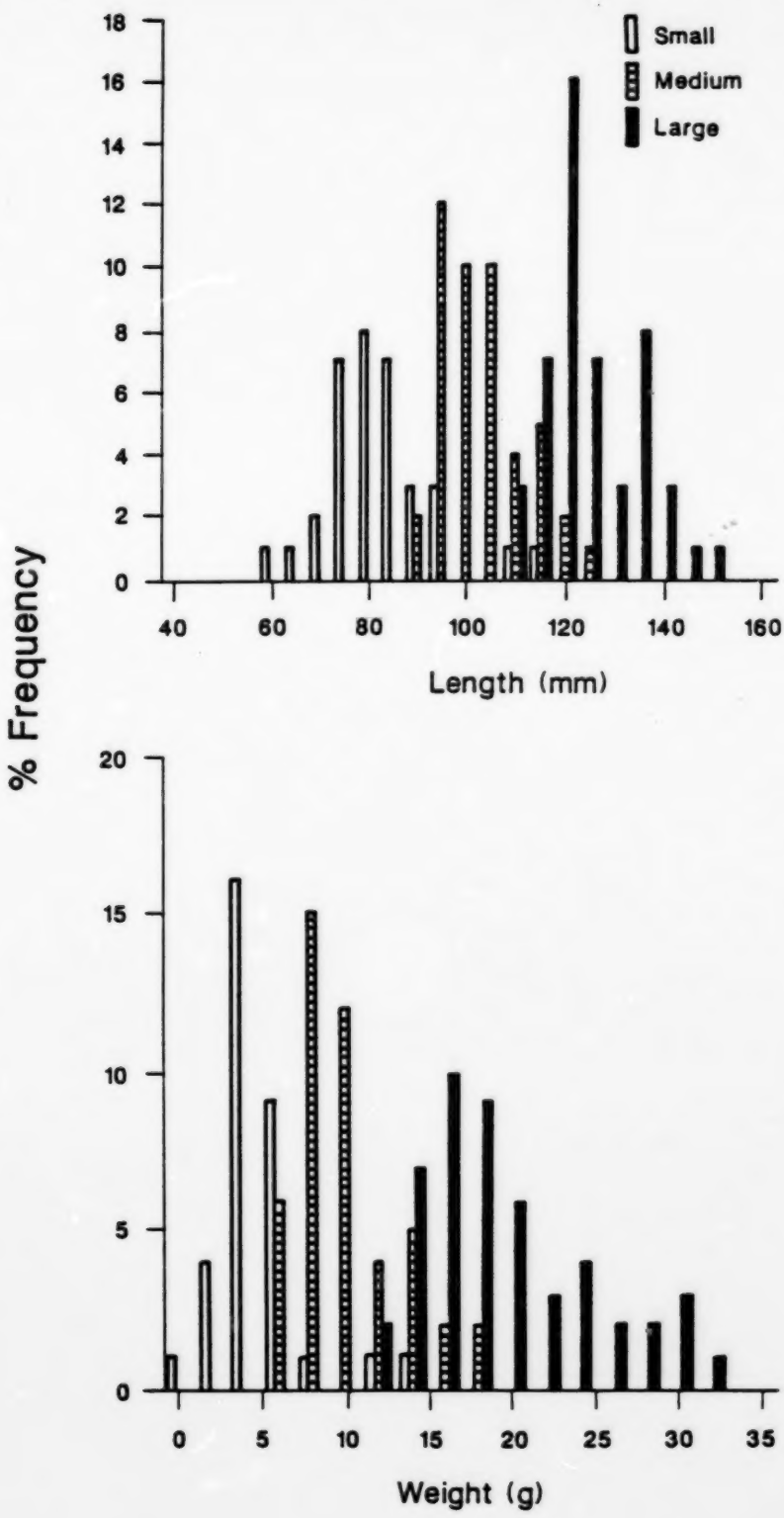

Fig. 1. Initial length and weight frequency of the graded size classes at time of stocking into Pikes Lake.

GROWTH

Mean lengths and weights of the graded size classes remained significantly different (GT2 test, $P < 0.05$) at the termination of the experiment (Table 2). Growth rates, however, indicated an overall trend of decrease from the small to the large graded size group. Instantaneous growth rates were 2.1, 2.0, and 1.9% of body weight per day, for the small, medium, and large groups, respectively. All fish in the medium and the large size groups were of a catchable size (> 225 g) at the time of fall sampling. Weights ranged from 234 to 816 g for the large grade group. All fish in the small size group weighed less than 225 g.

Table 2. Final lengths, weights, and instantaneous growth rates (Gw) on October 23, 1987 (SD in brackets). Growth rates are given as per cent of body weight/day.

Grade	N	Mean Length (mm)	Mean Weight (g)	Gw (Δt=169 days)
Small	88	249.1 (27.7)	208.6 (69.8)	2.1
Medium	138	288.5 (26.4)	329.7 (88.8)	2.0
Large	208	328.2 (23.3)	495.7 (115.9)	1.8

In a comparison of males only, mature males in the large group weighed significantly more (GT2 test, $p < 0.05$) than the immature males of that group and more than any males in the small or the medium size group (Table 3). Mature males grew at a faster rate than the immature males in both the large and the medium grade groups, but at a slower rate in the small grade group. Immature males in the small grade grew at the fastest rate of 2.2% body weight per day (Table 3).

Table 3. Comparison of length, weight, and instantaneous growth rates (Gw) for males in each graded size class. Growth rates are given as per cent of body weight/day.

GRADE	n	% N	Mean Length (mm)	Mean Weight (g)	Gw (Δt=169 days)
Small					
Mature	31	83.8	250.5	217.8	2.1
Immature	6	16.2	268.8	260.4	2.2
All Males N =	37		253.5	224.7	2.1
Medium					
Mature	71	93.4	296.4	359.9	2.1
Immature	5	6.6	284.0	312.2	2.0
All Males N =	76		295.6	356.8	2.0
Large					
Mature	124	87.3	337.3	544.3	1.9
Immature	18	12.7	321.6	457.6	1.8
All Males N =	142		335.3	533.3	1.9

MATURATION RATES AND SEX RATIOS

Early sexual maturation rates (Table 4) were negligible for the females in all groups (1.0% for the large grade females).

Table 4. Sex and maturity in the three graded size classes on October 23, 1987.

		Males				Females				
		Mature		Immature		Mature		Immature		Sex Ratio
Grade	N	n	%	n	%	n	%	n	%	M:F
Small	88	31	35.2	6	6.8	0	0	51	58.0	0.7:1
Medium	138	71	51.5	5	3.6	1	0.7	61	44.2	1.2:1
Large	208	124	59.6	18	8.6	2	1.0	64	30.8	2.1:1

Male maturation rates were 35.2, 51.5, and 59.6 per cent in the small, medium, and large grades over the whole population. Maturation rates of the males only were 83.8, 93.4, and 87.3 per cent for the same respective groups (Table 3). No significance is attributed to the difference in proportion of mature males per grade (G test, $P > 0.001$).

A significant difference was found between sex ratios of the three groups (G test, $P < 0.001$). The large size class contained 2.1 times more males than females, whereas the small and medium size grades yielded respective ratios of 0.7:1 and 1.2:1 males to females (Table 3).

RELATIVE SURVIVAL

The graded class structure of the population of fish existing in Pikes Lake was estimated from the relatively large sample ($N = 434$) collected in the fall.

The large grade class comprised 48% of the total catch, the medium grade, 32%, and the small grade, 20% (Table 2). Apparent relative survival was 2.4 times greater in the large size class than the small grade.

DISCUSSION

Productive, barren lakes subject to winterkill can provide optimum growth conditions for rainbow trout in the first year of stocking (Tsumura, Hume and Chan 1987). Many such lakes exist in British Columbia and would provide ideal habitat for the development of a fall and winter ice fishery (Tsumura, Hume and Chan 1987). Lakes which winterkill annually and therefore require catchable size fish for stocking, presently remain unused due to the high cost of growing trout to catchable size before release. Artificial circulation programs may alleviate winterkill problems, but are impractical for small isolated lakes where capital and labor expenditures usually exceed benefits (Ashley 1987).

High growth rates were observed in all three size classes of fish in this study, but only the medium and the large grades grew to a catchable size within the short growing period. The fish in the large grade class maintained size superiority over the medium grade fish and, therefore, would be more acceptable to anglers.

Although similar rates of early sexual maturation were observed in the males for all grade groups, more precocious males were present in the large size class due to the 2:1 male to female sex ratio in this group. These results differ from a similar experiment conducted in a hatchery by Tsumura and Hume

(1986), where the rates of early sexual maturation in the males were 3.6, 23.7, and 84.1 per cent compared to 83.8, 93.4, and 87.3 per cent in this study for the small, medium, and large grades, respectively. In the previous study, average growth rates for the males were 1.4, 1.5, and 1.4% of body weight/day for the small, medium, and large grades; whereas in this study, the rates were 2.1, 2.0, and 1.9% of body weight/day for the same respective grades. These differences in growth rates and observed maturation rates suggest that in highly productive barren lakes, the majority of males would mature early, irrespective of initial length or weight at time of stocking. However, grading and stocking large juveniles in winterkill lakes is still preferable because of their 2:1 male to female sex ratio, high relative survival, and large size at capture. These results support recommendations made by Tsumura, Hume and Chan (1987) for stocking winterkill lakes.

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Appendix 1. Expected benefit-cost of stocking Pikes Lake with large, graded one year old rainbow trout if the lake was open to angling. Benefit-costs comparisons are derived from the mean of predicted values for Okanagan area lakes reported by Ashley (1987). Average cost of producing rainbow trout to age 1 at the Summerland Trout Hatchery is estimated to be $31.00/kg (Hugh Sparrow, pers. comm.).

Expenses:

Cost of 20 g fish - $0.63 x 6000	$3720.00
Grading cost - 2 person days	200.00
Stocking cost - 2 person days plus vehicle . . .	300.00
Total expenses . . .	$4220.00

At a value of $20.00 per angler day (Ashley 1987), a break-even point will be reached if 211 angler days or 9.4 angler days/ha was realized before the lake winterkilled. It is apparent that a fall and winter fishery developed on a barren winterkill lake utilizing large graded fish is cost-effective at low angler effort.

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